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ABSTRACT

Piaget's last works (1975, 1977, and 1980) add a dynamic aspect to his earlier exceptionally formal structural model. He portrays change in more functionalistic terms and describes conflict, referring to the process of perturbations and compensations to explain the regulations of the network of cognitive cycles. He suggests three types of balances or compensatory responses: Alpha, Beta, and Gamma compensations. These writings, however, ignore the social aspects in Piaget's functional analysis. On the other hand, Doise explicates social cognitive research paradigms which induce cognitive development, but he ignores the functional analysis of the peer interaction. Taken together, these two lines of research appear to complement each other. The present study attempts to join and extend these two theoretic positions. A total of 50 children from 8 to 10 years of age worked in triads (composed by similar or different age levels) and alone during five independent sessions on selected Piagetian experiments in contradictions. Results showed: (1) in general, co-construction produced earlier, more significant, and generalizable progress than individuals working alone and (2) in a qualitative exploratory analysis, increasing levels of compensations (Alpha, Beta, and Gamma) were identified, providing information on the gradual coordination between competing affirmations and negations. (Author/RH)

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"Perturbations and Compensations in Social Cognitive Conflict: A Functional Analysis of Cognitive Development"

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ABSTRACT

Piaget's last work (1975, 1977, and 1980) add a dynamic aspect to his earlier exceptionally formal structural model. He portrayed change in more functionalistic terms and describes conflict referring to the process of perturbations and compensations to explain the regulations of the network of cognitive cycles. He suggests three types of balances or compensatory responses: Alpha, Beta and Gamma compensations. These writings, however ignore the social aspects in his functional analysis. Doise and his colleagues (1975, 1976, and 1981) with research into social cognitive conflict suggests that change and development is facilitated by peer interaction but they ignore the functional analysis of social collaboration. Taken together, these two lines of research appear to complement each other. The present study attempts to join these two thrusts in an attempt to extend both theoretic positions. Fifty children from eight to ten years of age worked in triads (composed by similar or different age levels), and alone, during five independent sessions on selected Piagetian experiments in contradictions. Results showed: (1) in general, co-construction produced earlier, more significant and generalizable progress than individuals working alone, and (2) in a qualitative exploratory analysis, increasing levels of compensations (Alpha, Beta and Gamma) were identified, providing information on the gradual coordination between competing affirmations and negations.

INTRODUCTION

The present investigation was an attempt to join two recent developments in cognitive research: (1) social cognitive conflict that suggests that change is facilitated by peer problem solving and (2) Piaget's new equilibration model which explicates in functionalistic terms the process of perturbations and compensations in the development of knowledge.

THE SOCIAL ASPECT OF COGNITION

For social psychologists it has long been obvious that social factors intervene in cognitive development (Kelly et al; 1984). In the contemporary research, two main directions can be distinguished. The first, called "social learning," attempts to explain the subject's development by the process of imitation, in particular, imitation of models ("modelling effect"). The cognitive growth stimulated by exposure to a developmentally "superior" model have been studied widely. Turiel (1966), McManis (1974) have worked on moral development; Rosental and Zimmerman (1972) and Zimmerman and Rosenthal (1972, 1974) have focused on concept formation; others have experimented specifically on conservation as Wagborn and Sullivan (1970), Zimmerman and Lanaro (1974), Murray (1974), Botvin and Murray (1975), etc. The majority of these studies agreed that the imitation of a developmentally superior model was the most influential factor for change. Some studies tried to observe the reverse effect, to model non-conserving responses

after a non-conserver model, as an example, Cowan et al. (1969) found that the training of behaviors by an inferior model was less effective than the contrary situation. Kuhn (1972) and Rosenthal and Zimmerman (1972) showed that the modelling effect was weak in the reverse direction. Murray (1974) submitted a group of conservers to an inferior model and none of them did regress. These facts seem to demonstrate that there are other factors involved which cannot be explained by a simple imitation effect.

The second trend relates to the social interaction (peer-interaction, cognitive conflict, etc.) which focused specially on the process of restructing induced experimentally by presenting the child with another child whose behavior are developmentally more advanced, less advanced or at the same level, thereby creating disequilibrium between the subjects. This approach is most inspired by Piaget's works in the interactionist and constructivist tradition. From a Piagetian position, imitation might have some local and immediate effect on behavior, but being essentially an accommodating process would not induce any genuine growth. Piaget recognized that cognition is in some aspects social but did not treat it explicitly as a social phenomenon. Piaget has considered it impossible to establish a causal link between the development of what he calls "social logic" and the development of the "individual logic" (Piaget, 1965).

Some researchers have proposed that the focus of research in cognitive development should change emphasis from interaction between the subject and non-human environment towards a more social kind of interaction (Vygotsky, 1962; Smedslund, 1966). A rather new line of social-interaction research has come from the work of William Doise and his colleagues from the University of Geneva (Doise, Mugny, and Peret-Clermont, 1975, 1976; Doise, Mugny, 1978, 1979; Doise and Mackie, 1981). This group of social psychologists disagree with the Piaget's assumption that social logic and individual logic are two inseparable aspects of a single reality.

Followers of the cognitive conflict approach consider the principal function of the interaction to be the decentering of the subject caused by contradictory or conflictive centrations.

A review of the experiments made by Doise and his colleagues can be summarized: (1) groups in a conflictual situation tend to develop a better organization of criteria than individuals working alone, (2) in interaction, subjects indeed reach higher levels of performance which individuals cannot attain alone, and (3) construction of new coordination depends on the individual's resolution of conflicts between his or her own centration and those of the others. "The path of cognitive development appears to be from the inter-individual or social to the individual. By coordinating their actions with the actions of others, children progress

cognitively and are able to participate in even more complex interactions which allow yet more progress to be made." (Doise and Mackie, 1981, p. 78.)

PIAGET'S NEW EQUILIBRATION MODEL: A DYNAMIC APPROACH TO COGNITIVE DEVELOPMENT

In his last publications, Piaget shifted his explanation from the description of stages in terms of formal structures towards a more functionalistic and psychological process model. Piaget's new equilibration model appeared on press in 1975. The English version, "The Development of Thought Equilibration of Cognitive Structures," was published two years later. This version is full of mistranslation and distortions. In this present study, the original in French was used.

Piaget's concept of equilibration is described as the self-regulator of the human knowledge. In his last works he portrayed change in more functionalistic terms and he explains conflict referring to the processes of perturbation and compensation among internal and external systems of knowing. He suggested three types of balances to explain the regulations of the network of cognitive cycles. Every regulation is a reaction to a perturbation, and a new regulation is at once both constructive and compensatory.

Piaget, in his new model, suggests three types of balance or compensatory responses: (a) Alpha compensations or alpha behavior, concerning the assimilation-accommodation cycle which

constitute the most basic forms of knowing involving the activity of the individual in the subject-object relationship. Facing a contradiction the subject will reject, modify or distort it in order to adjust to the available cognitive system.

The second balance concerns the relations between schemes or subschemes which leads to a differentiation and a coordination of schemes. This behavior, called Beta compensations consists in the integration into the systems the element of perturbation. What was disturbing is transformed into internal variation. The compensation is still partial but nevertheless in a superior manner than the previous level.

A third type of equilibrium occurs when the compensations regulate the hierarchical integration of schemes with the higher order totalities. This superior behavior is called the Gamma compensations or the gamma behavior.

There is a systematic progress of these three general phases of the cognitive system at every level are based on compensations but their significance is deeply modified at distinct degrees of equilibrium. At the first level, the equilibrium is unstable or restricted. The second level shows displacements of equilibrium, and the third level is related to a flexible but more stable equilibrium integrated in the structure of the whole.

The instability of equilibrium as in the alpha behavior is explained by the fact that the subjects focus mainly on the

affirmations (the positive properties of the objects) and they are unable to construct negations. At the Beta compensation level, the subjects create an accommodation of their own schemes and the subjects become aware of the negations. They accommodate therefore reequilibrate. As a result of this equilibrium, there is an incorporation of new assimilatory strategies to the repertoire of the subject's cognitive system (and behavior).

One of the most important features of the new equilibration concept concerns the relations between the empirical abstraction (figurative knowing) from the objects or observables and the reflexive abstraction (operative knowing) from the coordination of actions. From this new position Piaget considered that at all levels, there is interaction between observables and coordinations, hence there is collaboration at every level between empirical and reflective abstraction.

For Piaget (1975) his new equilibration model represents a possible synthesis of his previous works in genetic structuralism and the functionalism expressed in the work of J. Dewey and in many aspects of the Freudian psychoanalysis (Piaget, 1975).

At each level of the development, the structural model uses specific types of compensations. The process model, through compensations, restores unbalanced equilibriums promoting a novel construction. "It would appear that the structural model, since it is based on a developmental hierarchy of structures can absorb

the process model. In fact, if we want to find the components that are common to both we should think of the all important concept of compensations. . .the compensations in the structural model thus finds their dynamic explanations in the process model: And the way these new combinations act finds explanations in the structural model" (Inhelder, 1977, p. 64).

Disequilibrium for Piaget is the driving force of the development. Without disequilibrium, knowledge would remain static. Equilibration is present in all levels of development.

Any reequilibration is a reaction to a perturbation, but not all perturbations leads to progress, the subject must grasp some awareness of the situation in order to profit from it. Piaget calls "state of cognitive gap" the situation where the subject is in some respect conscious that something is missing, and in order to overcome a gap, a compensatory system of regulations come into play (Piaget, 1975).

The fundamental problem is to establish the general reasons for the initial primacy of affirmations over negations in all levels of behavioral hierarchy. The positive characteristics or affirmations means knowing what the object is by a simple observation of properties (attribution of a quality, "blue"). The negative characteristics, briefly means what an object is not. Negations are the non-qualities of an object such as "not blue" (the negation of a ball is that the ball is not square).

At the sensory-motor level, there are movements directed at removing an obstacle subordinated to a positive goal but not feedback or retroactions. Schemes of assimulation are centered first of all on "comprehension" without consciousness yet of the "extension." The kind of motor or practical negations at this level tends to suppress or neutralize a perturbation. Correspond to the alpha behavior in the domain of equilibration.

At the level of the pre-operatory conceptualization there is the formulation of elementary negative movements but always in relation to previous positive affirmations. The common characteristics of the objects are organized in the form of more or less coherent system of class and relations. The new kind of negation is no longer practical but constatative, permits the integration in the systems of an increasing number of external perturbations correspond to the behavior in the domain of equilibration.

At the operatory level--each affirmation has its corresponding negation in the form of reverse operation. Negations develop according to two processes: Internalization (assimilation) and relativization of negations (accommodation), these two processes corresponds to the gamma behavior in the domain of equilibration. The achieved equilibrium includes compensations and consequent precorrections or avoidance of error.

One of the fundamental aspects of the development of behaviors from type alpha to type gamma is the internalization of negations

that are integrated in a certain succession of variations until this structure becomes operational (in form of inverse operation).

Recalling the experiment of the ball of clay extended into a sausage, Piaget describes different levels of compensations. At the first level, there is a kind of repression of observable properties, or the child ignores the contradiction, although it is quite perceptible, which is a type alpha behavior. After fluctuations, the thinning at the next level becomes bound up with the stretching out, and thus no longer constitute a disturbance but a variation integrated in the system, this is the result of type beta behavior. Finally, this variation becomes by deduction a necessary and essential feature to integrate subsystems into whole systems, with its inverse operation. At this operatory level, reversibility becomes an interiorized action. This type gamma behavior ensures an exact correspondence between negations and the affirmations.

In relationship to the three principal levels of cognitive functioning, Piaget presents three successive types of compensations that relate to the interdependent cycles of reequilibrations in which the subject-object cycles are part of the between subsystems cycles which becomes part of the totality cycles. Coherent overall systems in fact can be observed as early as operatory levels of psychogeneses, the stage of concrete operations.

GOAL OF THE STUDY

This study was designed to bring together two recent developments in cognitive development theory. First, Doise's (1981) social cognitive conflict research which demonstrates the value of peer cognitive conflict in inducing cognitive growth. Second, Piaget's last work (Experiments in Contradictions, 1980 and Equilibration of Cognitive Structures, 1975) which adds a functional psychological aspect to his logico-mathematical structural model. This new functional aspect provides strong guidelines for the analysis of cognitive development by way of charting levels of compensations in the equilibration cycle.

Taken together, these two lines of research complement each other. Piaget explicitly recognizes social conflict as a source of development but ignores social aspects in his functional analysis. Doise explicates social cognitive research paradigms which induce cognitive development, but ignores the functional analysis of the peer interaction. The present study combined these two recent perspectives into a whole, where social cognitive conflict was induced using Doise's paradigms and an exploratory protocol analysis was conducted to shed some light into the functional processes within the social interaction.

EXPERIMENTAL PLAN AND PROCEDURES

To study the effect of social interaction on operational development, a group of children were tested on some of the latest

Piagetian experiments. Children were from the school Objectivo Junior, Sao Paulo, Brazil, located in a middle to high class neighborhood.

In order to emphasize conflict resolution an extended period of testing was observed. The design involved individual pre-testing, a period of three consecutive intervention sessions (once a week) and a month after, post-testing. On the basis of a pre-test individually administered from a group of 70 children, two groups of children were selected: More advanced subjects (MA), children who compensated correctly all the perturbations; and less advanced subjects (LA) who only partially or didn't compensate at all the disturbances elicited by two of the experiments used in the pre-testing phase, "The Hanoi Tower" and "Relative Movements" (Piaget, 1976 and 1980).

During the three intervention sessions, children were tested in triads or individually. Ten groups of children interacted in triads of two forms: (a) heterogeneous, triads composed by one MA subject and two LA children, and (b) homogeneous triads formed by LA subjects only. In the control group, ten LA and ten MA children worked alone during the three intervention sessions.

Adopting the critical method of exploration developed by the Genevan School, the experimenter actively promoted, when necessary, the desired confrontation among the children. At each new situation the subjects were asked to express judgments, predictions, and

anticipations. In relation to the children of the control group, tested individually, counter arguments were presented by the experimenter.

Material

From the last Piagetian publications, three experiments were selected: From his book Experiments in Contradictions (1980), "Contradictions in Case of Multiple External Factors and Simple or Reciprocal Transfer," and from Grasp of Consciousness (1976), "The Hanoi Tower."

In "The Hanoi Tower" experiment (Piaget, 1976, p. 287), the material consisted of three posts, 1, 2, and 3, attached to a baseboard. A graduated set of three discs (small, medium and large) with a hole in the center. The discs are placed on 1, the starting point, the largest disc on the bottom, the medium one, and the smaller one on top. Subjects are told to move the discs from post 1 to post 3, respecting the same order at the end. The children are asked to move the pyramid of discs on 1 to 3, the finishing post. Observing the following rule: (1) only one disc at a time can be moved, (2) never put a larger disc on top of a smaller one, and (3) never hold a disc in hand or place on the table while another is moved. The post 2 is to be used as a "storage" post. For three discs, the optimal performance is seven moves.

In the experiment "Contradiction in Case of Multiple External Factors" or "Relative Movements," (Piaget, 1980, p. 268) the

equipment consisted of a long cardboard tunnel with a top that opens so that one can see inside and a little train that runs through it. Two people, A and B, remain in different positions at the beginning or at the end of the train. It is important to emphasize that the speed is always constant. According to the position of the people on the train in the front, in the back, at the middle, walking along inside the train, etc., the problem is being whether one of the people will stay longer than the other or both will stay in the same amount of time. Four different situations were part of the test: (1) one traveler is seated in front of the train and the other is seated in the back of the train, (2) the traveler in the front of the train moves towards the one in the back and vice-versa, (3) the traveler at the front moves toward the back but when he is about half-way he goes back to the front of the train to reach a newspaper before setting off again towards the direction of the other one in the back of the train, (4) both travelers at the front of the train, one remains seated and the other moves towards the end of the train, and vice-versa, both at the end of the train, and when the train enters the tunnel, one remains seated and the other moves forwards towards the front.

The third experiment, "Simple Transfer of Counter Between Two Corresponding Series" (Piaget, 1980, p. 160), this problem was designed to investigate the transfer of elements from one collection to another where both collections at the outset are equal. The

material consisted of approximately twenty coins and one screen. Two collections had to be formed by an equal number of elements. According to the number of coins that the experimenter anticipates that he is going to transfer, the subject has to predict the difference between the two collections. The transfer is carried out by the experimenter under the cover of the screen. After a verbal prediction by the child the screen is removed for verification. Successful subjects predict that the difference is 2n not n as apparently is perceived by subjects. Three different sets of collections and procedures were used accordingly: (1) two collections of three elements, transfer of one; (2) two collections of four elements, transfer of two; and (3) two collections of six elements, transfer of three elements.

RESULTS

A. FIRST EXPERIMENT

The Hanoi Tower

QUANTITATIVE ANALYSIS

In "The Hanoi Tower" problem, one of the criteria for measuring the performance was the total number of moves to solve the problem. Level 4 performance was considered the most advanced performance, seven moves. One to three additional moves would count for level 3 performance (8 to 10 moves). From eleven to twenty moves, level 2 performance, with partial, incomplete but

finally correct solution. More than 20 moves was considered as level 1 performance with no plan or compensations at work.

The statistical analyses showed a significant difference in the increase of levels of performance favoring the collective condition among lower level subjects with a F value of 9.93 ($p < .002$). Higher level children also had profited from the interaction with lower level ones. Statistical comparison between advanced subjects showed an F value of 7.75 ($p < .007$) in favor of those who interacted over the subject that worked alone.

Insert Table I and II about here

An analyses by levels of performance seems to confirm consistently the hypothesis that social interaction facilitates and promotes cognitive change. Table I and Table II show successively at each intervention session the levels of performance reached by each subject. The fluctuations observed in several cases demonstrate the difficulty to transfer the full concept of the strategies in action from one session to the next. Children from heterogeneous triads were the ones who had profited the most from the interaction with the possibility of a maximum of three levels increase; this collective modality showed an average improvement of 2.2 levels of performance. Triads composed by three lower level subjects increased an average of 1.53 levels. The statistical analyses of

the contrast between low level subjects that worked in interaction and the same level subjects that worked alone presented an F value of 9.93 ($p < .002$). A significant difference on progress of levels of performance was revealed by their compared means.

It is important to notice that higher level subjects that worked in cooperation with others of inferior levels also profited from the collaboration. An analysis between the more advanced subjects that interacted and that worked in isolation yielded an $F = 7.75$ ($p < .007$) showing that they also improved significantly from the social exchange. There were no statistical evidence of difference in the overall performance among less advanced or more advanced subjects that collaborated. Both groups gained from the interaction.

The profiles of children shown in Appendix A retraces the position of each child inside his or her own triad in levels of performance attained. Appendix B shows the profile and fluctuations of those who worked individually.

QUALITATIVE ANALYSIS

Level 1 - ALPHA COMPENSATION (No compensation)

Failure in the performance typical of subjects showing a long period of trial-and-error with the tower task without any plan, disobeying the instructions, etc. they were concentrating in only one aspect of the movement. Their actions were directed towards immediate goals (affirmations) without compensating with

respective negations. They just keep acting as if the solution would occur by chance (which happened in some cases).

Level 2 - BETA COMPENSATIONS (Partial compensations)

At this stage children were more organized in their actions. They were able to differentiate the elements of the problem and they could perform local compensations, following the rules and correcting themselves. an intuition of reversibility was beginning to appear or they were this time considering peg 2 as a storage or transitional element for the solution. They were not able to predict or anticipate solutions but proceeding by local or partial compensations, but with a focus on peg 2 as a storage element.

Level 3 - GAMMA COMPENSATION (Deductive compensations)

Deductive compensations where possible through differentiation and utilization of all the elements into the system of operation. Thought predictions and anticipations performance were possible without unnecessary moves. By reflecting on the task (reflexive abstraction) subjects elicited a sort of general model. This behavior seemed very close to what Piaget calls an operating deduction: "The necessity of compensations is imposed through a set of reflexive abstractions retroactively modifying the actual interpretation of the actions and not simply resulting from success or failure" (Piaget, 1976, p. 299).

B. SECOND EXPERIMENT

RELATIVE MOVEMENTS EXPERIMENT - CONTRADICTIONS IN CASE OF MULTIPLE EXTERNAL FACTORS

QUANTITATIVE ANALYSIS

The task in the experiment on "Relative Movements" was to reveal the understanding that the time a person spent in a tunnel while a train moving through it changes depending upon the person's movement. The problem is whether the travelers stay a longer or a shorter time inside the tunnel according to whether the traveler remains seated, walks in the same direction of the train (and visa versa). Four different situations were presented to the children (see procedures section).

Results in this experiment confirmed evident gains among the subjects, that interacted comparing less advanced subjects that worked alone or in triads according to situation 1, statistical analysis supports a significant change from the pre- to the post-test favoring those who worked in collaboration ($z = 1.73$, $p < .05$). The group of less able children that worked individually the change from incorrect responses to correct one was not supported by the analysis ($z = .378$, $p > .05$).

Insert Table III about here

The results presented on Table III show that high level subjects that interacted with lower level children also had improved. The poorest performance came from lower level children individually tested. Considering situations 1 and 2, at the post-test, 78.25 percent of lower level subjects that collaborated were successful, in contrast, only 30 percent of lower level subjects that worked individually could perform the task. Cooperation with others seems to bring about significant growth.

QUALITATIVE ANALYSIS

Level 1 - ALPHA COMPENSATIONS (No compensations)

Children were concentrating only in affirmations, mainly in the point of arrival of the train. Generally, the last traveler to leave the tunnel will be the one who stays in longer. They were not compensating for the movement of the train and movements relative to the travelers along inside the train. Centering only in the final action, they were not bringing into relationship the starting movements (direct operation without reverse operation). R.U. (8 years old) explained: "The one who is driving (front) will stay in longer because he is driving. . .he is pulling the train." A.D. (8) affirmed: "The one in front will stay in less; the one in the back will stay in longer, he gets out of the tunnel after the other."

Level 2 - BETA COMPENSATIONS (Partial compensations)

Subjects at this level were capable to differentiate the elements of the situation. They were obtaining a more correct explanation of the in-tunnel durations and some improvements were evident in comprehension and explanation of the task. Better relations between starting and emerging points, but they usually had forgotten to take into account all the facts involved in simultaneously coordination of the movements of the train and travelers as well. A.N. (8.7): "The one in the front will stay in longer; he will get out after the other." (Correct prediction but wrong explanation.)

Level 3 - GAMMA COMPENSATIONS (Deductive compensations)

Predictions and anticipations attested the correct coordination of all elements of the situation. Each perturbation was treated with corresponding compensations (correct relations between affirmations and negations). Some children had explored other situations besides the ones of the problem (as in the case of a traveler that would run faster than the train). There was coordination of the relative speeds and displacements. A.L. (10.3): "The man in the front and the man in the back (seated), they both will go through the same tunnel that is the same size. They also go through the tunnel at the same speed. . .so they will stay inside the same amount of time."

C. THIRD EXPERIMENT

Simple Transfer of Counters Between Two Corresponding Series

QUANTITATIVE ANALYSIS

This task was designed to study the problem of actions that are simultaneously positive and negative. The task was to predict and explain the transfer of n elements (coins) from one group to the other when both groups are equal at the outset. The less advanced subjects were predicting a difference of n, not of 2n. They were centered on the positive aspect of the action (adding n) and ignoring its negative aspect (subtracting n from the first collection). The resulting difference is represented by the increasing in the length of one row and a simultaneous shortening of the other. This task was difficult and intriguing for most of the subjects.

The analysis revealed a significant difference between the lower level subjects that worked alone or in triads with an F value of 13.79 ($p < .006$). Lower level subjects who interacted progressed significantly. Lower level children in the collective condition progressed to levels 2 or 3 in 67 percent of the cases. In contrast, the same population that worked alone only 13.4 percent had progressed and only to level 2, none reached level 3 of explanation.

Insert Table IV about here

According to Table IV, an overall score among the three situations of transfer showed that 34 percent of lower level children who interacted progressed to level 2 and 33 percent to level 3 performances.

Collaboration with less advanced children helped 66.7 percent of the more advanced group to reach level 3 performance. In isolation, only 30 percent of the advanced population attained a similar level. Comparing the two groups of lower level subjects, the control group with a mean .2 increase in level of performance and the experimental group with a mean increase of 1.25. There is statistical evidence that in collaboration less advanced children progress more than the control group.

QUALITATIVE ANALYSIS

Level 1 - ALPHA COMPENSATIONS (No compensations)

The children form the most elementary level by merely observing the transfer could not grasp the comprehension of the task. Children at this level would predict a difference of n instead of 2n. Despite being only one operation, there is a dissociation into two distinct operations. At this level there is what Piaget (1975) calls a repression of the observable properties, affirmations have absolute priority. They centered in the goal (positive

properties) and were unable to perform negations. C.A. (8.6), surprised and unable to explain said: "Is this magic?" A.N. (8.0), even after the verification (counting): "Well, it is easy if you move one, will have one more, that is it."

Level 2 - BETA COMPENSATIONS (Partial compensations)

Subjects at this level were aware that there was a problem or a contradiction, but for lack of full compensations the reciprocal operation was not possible yet. They were aware of the perturbations and were now intrigued by the 2n difference (instead of n), but could not grasp the simultaneous reciprocal operation. They were counting correctly and were given the correct result of enumerations but not effectuating reflective compensations. They perceive that the difference is more than n. J.P. (8.0) after the transfer of two elements from starting four element collection: "If you move two coins. . .I think the difference will be three. . ." After verification, he affirmed: "I knew was some more."

Level 3 - GAMMA COMPENSATIONS (Deductive compensations)

Predictions and full compensations of the reciprocal transfer were performed at this level. All the elements were considered as part of the double transformation of both collections. The "double" addition and the subtraction were simultaneously performed. Actions and retroactions were coordinated and integrated in a whole system that allowed the subjects to deduct and not just to perform by intuition. They were able to anticipate and explain

transfers solicited. J.U. (10.1), anticipating the transfer of two coins to a collection of initial four elements: "Well, both groups had four coins each. If this group gains two, the other looses two. Four, plus two is six and four minus two is two. The difference will be four, because if we subtract two from six, we will have four. It is always the double. If we move three coins, the difference will be six, and so on."

SIGNIFICANCE, IMPLICATIONS AND CONCLUSIONS OF RESULTS

Results of this experiment indicate that cognition is also social in nature. The new Piagetian equilibration model has the potential to set guidelines to identify levels of increasing compensations in the process of cognitive construction.

By coordinating their actions with the actions of others, children progressed cognitively and were able to collaborate in even more complex interactions, which allowed yet more progress to be accomplished. The shared involvement in the solution of a task promoted individualized progress. The path of cognitive development appears also to be from the interindividual or social to the individual and autonomous.

The important aspect of the interaction which promotes development seems to be the socio-cognitive conflict experienced from different perspectives. Conflict of centrations induces interpersonal coordinations. Before a certain level of cognitive

competence, children may not be in possession of the cognitive prerequisites necessary for the awareness of the problem. In this case, neither the collective nor the individual conditions can lead to progress. In case of a concept being developed, social interactions seem to be particularly effective in promoting further elaboration. The gains in cognitive capabilities during social interactions allows the subject to engage in other interactions from which he/she could not have been able to benefit working individually.

Children who were requested to coordinate their actions attained superior levels of performance than those facing the same task individually. Also, the performances expressed by the lower level children in homogenous triads demonstrated that from two equally insufficient arguments they can build an appropriate solution (two wrongs can make a right).

The degree of mutual collaboration is important for a more or less dynamic situation of conflict which seems to be an important factor in determining the productivity of the interaction. Merely perceiving another point of view is insufficient. In situations of interaction where subjects rarely took notice of the partner's argument or in the case of submissive partners, they didn't accomplish desirable growth.

Although the finding attested the general hypothesis that conflict of centrations experienced socially were the main factor

for progress, children who were exposed to a triad of heterogeneous composition seem to have profited more from the mutual collaboration. Less able children who interacted with an advanced level subject had experienced more diversity of opinions and a more stable set of interventions and corrections.

More advanced subjects that interacted with less advanced children had profited also from the interaction. They were able to increase in levels of performance at a more rapid pace and exhibited a more lasting and superior performance at the post-test.

The findings of this study are in contrast with the modelling theory. In group, even a presentation of an incorrect model can lead to progress. Even more advanced children were pursuing better levels of performance. Progress results more from the conflicts resolved in interaction than from the presentation of a correct solution.

This exploratory investigation appears to have offered practical and theoretical guidelines for further exploration of the topic. The thrust of this study seems to provide implications for a more detailed examination of the value of peer interaction in education, as far as teaching methods and learning procedures.

If development is to be characterized by its constructive nature, social interactions seem to offer evidence that knowledge can be enhanced by co-construction. Progress seems to be more

apparent when subjects of different or equal cognitive levels coordinate in co-operation different approaches to the same task.

The results of this experiment seem to have reinforced and extended previous studies on social cognitive conflict and there is evidence that Piaget's new equilibration model provides information and guidelines to detect and explain mechanisms underlying cognitive construction. Results appear to have facilitated the placement of Piaget's cognitive theory within an appropriate social context long neglected by Piagetian research.

BIBLIOGRAPHY

Cowan, P. A., Langer, J., Heavenrich, J., and Nathason, M. (1969). Social learning and Piaget's cognitive theory of moral development, Journal of Personality and Social Psychology, 11(3): 261-274.

Doise, W., Mugny, G., and Perret-Clermont, A. M. (1975). Social interaction and the development of cognitive operations, European Journal of Social Psychology, 5(3): 367-383.

Doise, W., Mugny, G., and Perret-Clermont, A. M. (1976). Social interaction and cognitive development--further evidence, European Journal of Social Psychology, 6: 245-247.

Doise, W., and Mugny, G. (1978). Socio-cognitive conflict and structure of individual and collective performances, European Journal of Social Psychology, 9: 105-108.

Doise, W., and Mackie, D. (1981). On the social nature of cognition. In Social Cognition, London, Academic Press.

Furth, H. (1981). Piaget and Knowledge (2nd ed.), Chicago, The University of Chicago Press.

Inhelder, B., Sinclair, H., and Bovet, M. (1974). Learning and Development of Cognition, London, Routledge & Kegan Paul.

Inhelder, B. (1977). Information processing tendencies in recent experiments in cognitive learning. In M. H. Appel and L. S. Goldberg (eds.), Topics in Cognitive Development, New York, Plenum Press.

Kelly, F. J., Brown, B., and Fox, C. (1984). Dialectics of social adaptation and individual constructivism, Genetic Psychology Monographs, 110: 259-287.

Kuhn, D. (1972). Mechanisms of change in the development of cognitive structures, Child Development, 43: 833-844.

McManis, D. L. (1974). Effects of peer-models versus adult models and social reinforcement on intentionality of children's moral judgement, Journal of Psychology, 87: 159-170.

Murray, F., Ames, G., and Botvin, G. (1977). Acquisition of conservation through cognitive dissonance, Journal of Educational Psychology, 69: 519-527.

Murray, J. P. (1974). Social learning and cognitive development: Modelling effects on children's understanding of conservation, British Journal of Psychology, 65: 151-160.

Perret-Clermont, A. (1980). Social Interaction and Cognitive Development in Children, New York and London, Academic Press.

Piaget, J. (1977). Problems of equilibration. In M. H. Appel and L. S. Goldberg (eds.), Topics in Cognitive Development, New York: Plenum Press.

Piaget, J. (1928). Judgement and Reasoning in the Child, New York, Harcourt-Brace.

Piaget, J. (1975). L'Equilibration des Structures Cognitives. Probleme Central du Developpement, Paris, Press Universitaire de France.

Piaget, J. (1977). Problems of equilibration. In M. H. Appel and L. S. Goldberg (eds.), Topics in Cognitive development, New York, Plenum Press.

Piaget, J. (1976). Grasp of Consciousness, Cambridge, Massachusetts, Harvard University Press.

Piaget, J. (1980). Experiment in Contradictions, Chicago, Illinois, University of Chicago Press.

Rosenthal, T. L., and Zimmerman, B. J. (1972). Modeling exemplification and interaction in training conservation, Developmental Psychology, 6: 392-401.

Smedslund, J. (1966). Les origines sociales de la decentration. In Psychologie et Epistemologie Genetique. Themes Piagetiens, Paris, Dunod.

Turiel, E. (1966). An experimental test of sequentiality of development stages in the child's moral judgement, Journal of Personality and Social Psychology, 3: 611-680.

Waghorn, L., and Sullivan, E. (1970). The exploration of transition rules in conservation of quantity (substance) using film mediated modeling, Acta Psychologica, 32: 65-80.

Vygotsky, L. S. (1962). Thought and Language, Cambridge, Massachusetts, MIT Press.

Zimmerman, B. J., and Lanaro, P. (1974). Acquiring and retaining conservation of length through modeling and reversibility cues, Merrill-Palmer Quarterly of Behavior and Development.

TABLE I

LEVELS OF PERFORMANCE ON THE "HANOI TOWER" TEST AT EACH SESSION DURING THE WHOLE EXPERIMENT LOWER LEVEL SUBJECTS IN SOCIAL INTERACTION CONDITION

Lower Level Interaction Subjects	Levels of Performance Intervention Pre	1	2	3	Post	Levels Progressed From Pre- to Post-Test
Low + Low + Advanced[1] N = 10						
JU	1	2	2	4	2	1
AL	1	2	2	4	2	1
FA	1	4	2	4	4	3
RO	1	2	2	3	2	1
RU	2	4	3	3	4	2
RI	1	4	2	2	4	3
JH	1	4	4	4	3	2
AL	1	2	4	4	4	3
MA	1	4	2	4	4	3
CR	1	2	2	4	4	3
Low + Low + Low N = 15						
CR	3	3	4	4	4	1
CA	1	2	2	4	4	3
MA	1	1	2	2	2	1
RU	3	2	2	2	4	1
MU	1	4	3	2	3	2
LU	2	1	3	2	2	0
WI	2	4	4	4	4	2
RO	1	1	1	4	4	3
MI	1	4	3	4	2	1
AL	2	1	2	4	4	2
RI	1	1	2	4	4	3
AD	1	1	4	4	3	2
TO	3	2	3	4	4	1
RI	2	4	3	4	2	0
JP	1	3	4	4	3	2

[1] In the treatment of these results, only the lower level subjects were considered.

TABLE II

LEVELS OF PERFORMANCE ON THE "HANOI TOWER" TEST AT EACH SESSION DURING THE WHOLE EXPERIMENT ADVANCED AND LOWER LEVEL SUBJECTS IN INDIVIDUAL (CONTROL) CONDITION

Individual Condition	Levels of Performance Intervention Pre	1	2	3	Post	Levels Progressed From Pre- to Post-Test
Advanced Level Subjects						
N = 10						
LU	4	2	2	4	4	0
RN	4	2	4	4	4	0
FE	4	4	3	3	3	-1
MA	3	2	2	2	3	0
RO	3	4	4	4	2	-1
EU	3	4	3	4	2	-1
RF	2	4	4	2	3	1
ER	2	2	4	4	4	2
AL	2	2	2	4	2	0
JO	2	1	2	2	3	1
Lower Level Subjects						
N = 10						
AN	2	4	3	1	1	-1
DE	1	3	3	2	2	1
DA	1	2	3	3	2	1
HE	1	1	2	2	4	3
FR	1	2	2	3	3	2
CL	1	2	2	2	2	1
RO	1	1	1	1	1	0
EL	1	1	1	1	1	0
DA	1	1	1	1	1	0
FA	1	1	1	1	1	0

TABLE III

PERCENTAGE OF CORRECT RESPONSES ON THE TEST OF "RELATIVE MOVEMENTS" IN SITUATIONS 1, 2, 3, AND 4[1]

	Pre-Test Situation		Post-Test Situation		Intervention Situation		Post-Test Situation	
	1	2	1	2	3	4	3	4
Lower Level Subjects								
Interaction Condition	50	53	71.5	85	90	96	84	92
Individual Condition	20	40	30	30	50	40	80	50
Advanced Level Subjects								
Interaction Condition	100	100	100	100	100	100	100	100
Individual Condition	90	80	80	80	80	80	90	100

[1] Situations 1 and 2 were tested on the pre- and post-test. Situations 3 and 4 were part of the second and third intervention session and used in the post-test.

TABLE IV

PERCENTAGE OF SUBJECTS IN THE TEST "SIMPLE TRANSFER OF CONTERS BETWEEN TWO CORRESPONDING SERIES" BY LEVELS OF PERFORMANCE ACHIEVED DURING THREE INTERVENTION SESSIONS AND THE POST-TEST. BOTH LEVELS, ADVANCED AND LOWER LEVEL SUBJECTS, IN THE TWO CONDITIONS, INTERACTION AND INDIVIDUAL.

Subject Level	Condition	Levels of Performance[1]	Intervention Sessions Technique 1	2	3	Percent Total	Post-Test Technique[2] 1	2	3	Total
Lower										
	Interaction	1 - NC	96	48	40	61.4	16	32	48	32
	N = 25	2 - PC	4	40	48	30.6	36	40	28	34
		3 - C	-	12	12	8	48	28	24	33
	Individual	1 - NC	90	90	90	90	80	90	90	86.6
	N = 10	2 - PC	10	10	10	10	20	10	10	13.4
		3 - C	-	-	-	-	-	-	-	-
Advanced										
	Interaction	1 - NC	20	-	-	6.6	-	-	20	6.6
	N = 5	2 - PC	40	20	20	26.6	-	20	-	6.6
		3 - C	40	80	80	66.6	100	80	80	86.6
	Individual	1 - NC	50	40	20	36.6	20	10	-	10
	N = 10	2 - PC	40	20	40	33.6	50	60	40	50
		3 - C	10	40	40	30	30	30	60	40

[1] Levels of performance: NC - level 1, no compensation; PC - level 2, partial compensation; and C - level 3, compensation.

[2] Technique from procedures: technique 1, two collections of three elements - transfer 1; technique 2, two collections of four elements - transfer 2; and technique 3, two collections of six elements - transfer 3.

APPENDIX

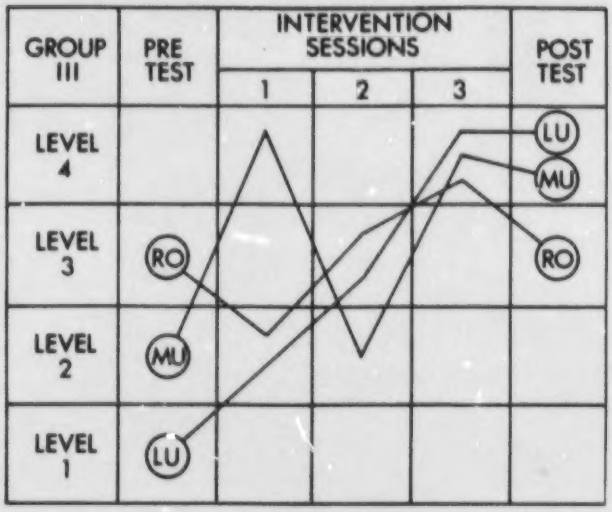
Figure 1

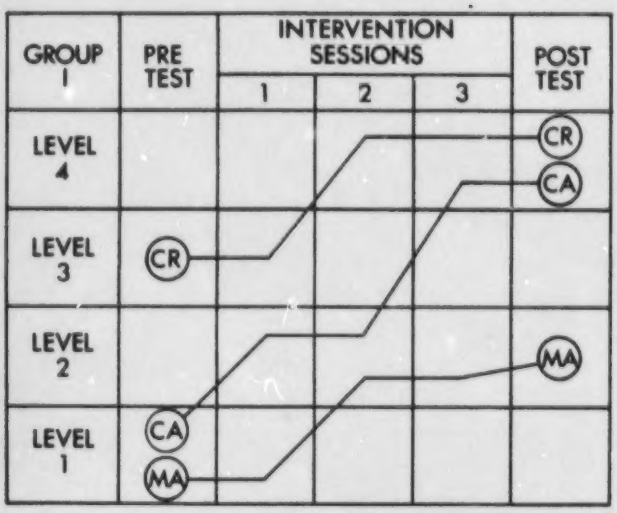
PROFILES BY LEVELS OF PERFORMANCE IN THE
TEST "THE HANOI TOWER"

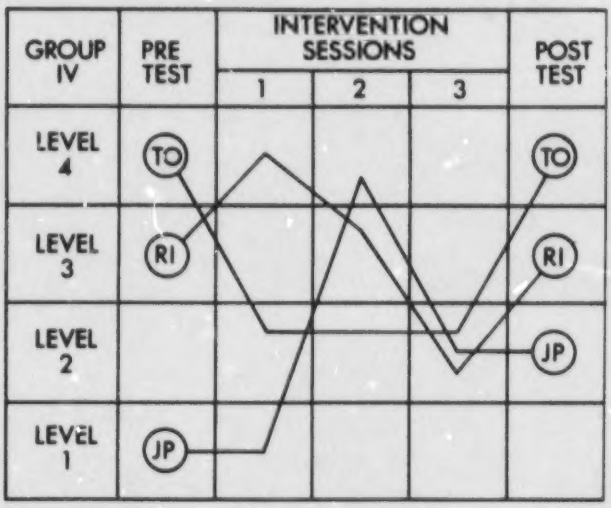
SPECIFIC POSITION OF EACH SUBJECT
AT EACH TESTING SESSION

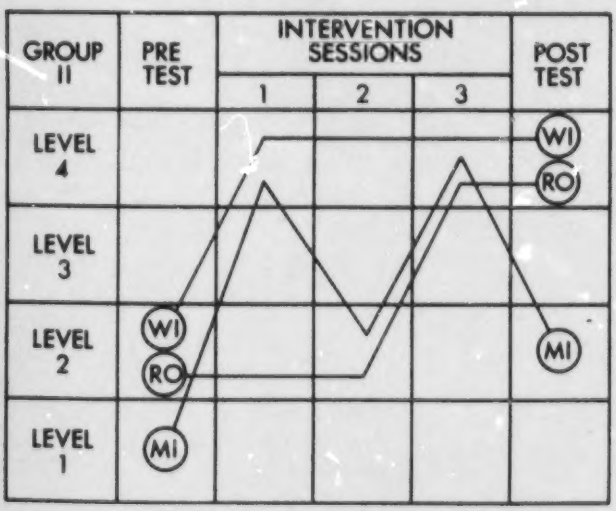
LOWER LEVEL SUBJECTS

SYMMETRICAL TRIADS


GROUP III
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
RO
MU
LU
LU
MU
RO


GROUP I
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
CR
CA
MA
CR
CA
MA


GROUP IV
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
TO
RI
JP
TO
RI
JP


GROUP II
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
WI
RO
MI
WI
RO
MI

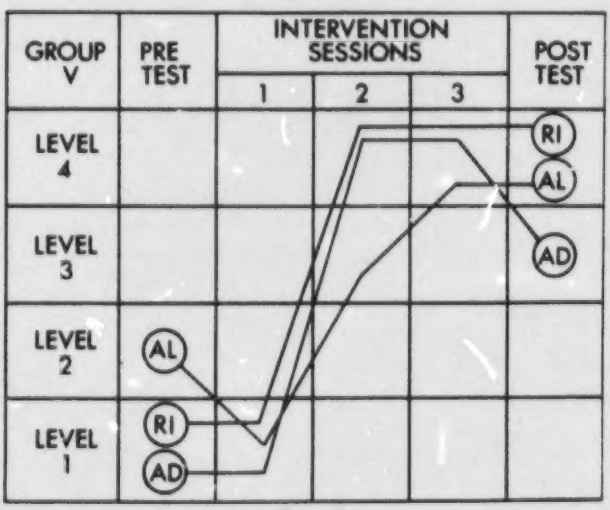
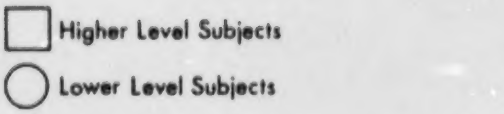

GROUP V
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
AL
RI
AD
RI
AL
AD

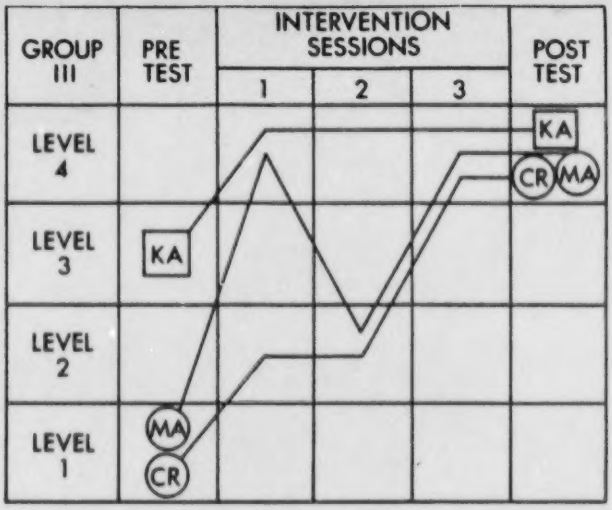
Figure 2

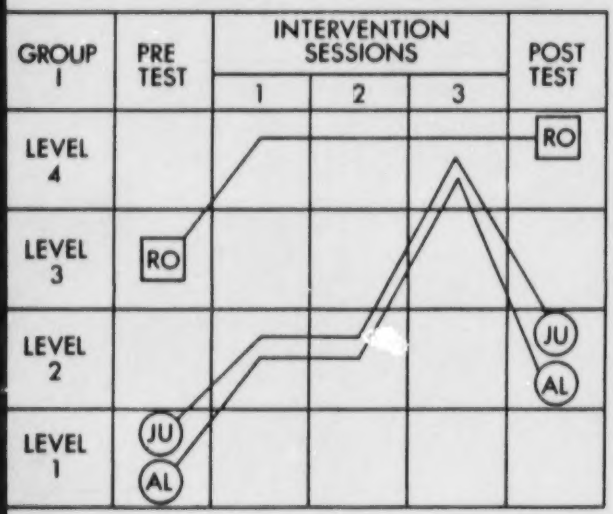
PROFILES BY LEVELS OF PERFORMANCE IN THE
TEST "THE HANOI TOWER"

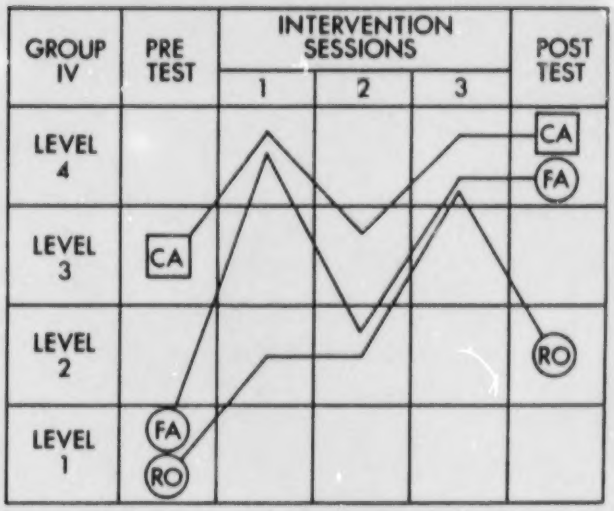
SPECIFIC POSITION OF EACH SUBJECT
AT EACH TESTING SESSION

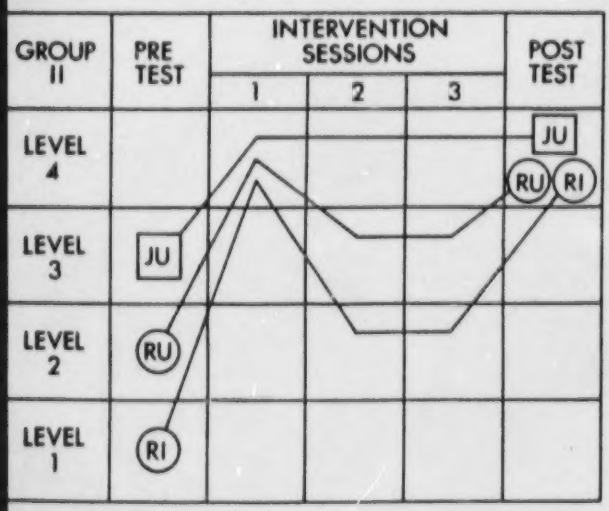
ASYMMETRICAL TRIADS


Higher Level Subjects
Lower Level Subjects


GROUP III
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
KA
MA
CR
KA
CR
MA


GROUP I
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
RO
JU
AL
RO
JU
AL


GROUP IV
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
CA
FA
RO
CA
FA
RO


GROUP II
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
JU
RU
RI
JU
RU
RI

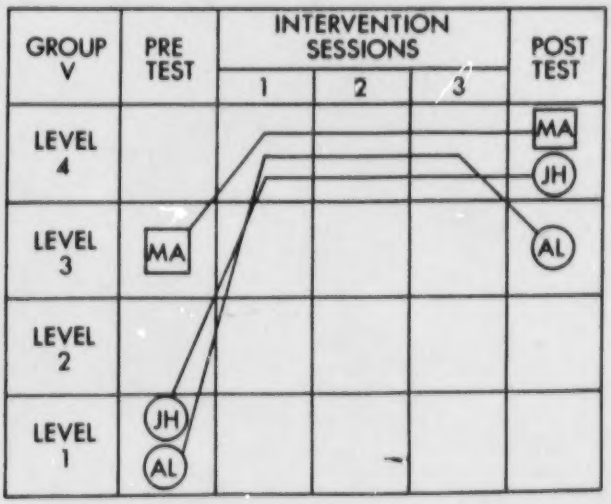

GROUP V
PRE TEST
INTERVENTION SESSIONS
1
2
3
POST TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
MA
JH
AL
MA
JH
AL

Figure 3

PROFILES BY LEVELS OF PERFORMANCE IN THE TEST "THE HANOI TOWER"

SPECIFIC POSITION OF EACH SUBJECT AT EACH TESTING SESSION

LOWER LEVEL SUBJECTS - INDIVIDUAL CONDITION

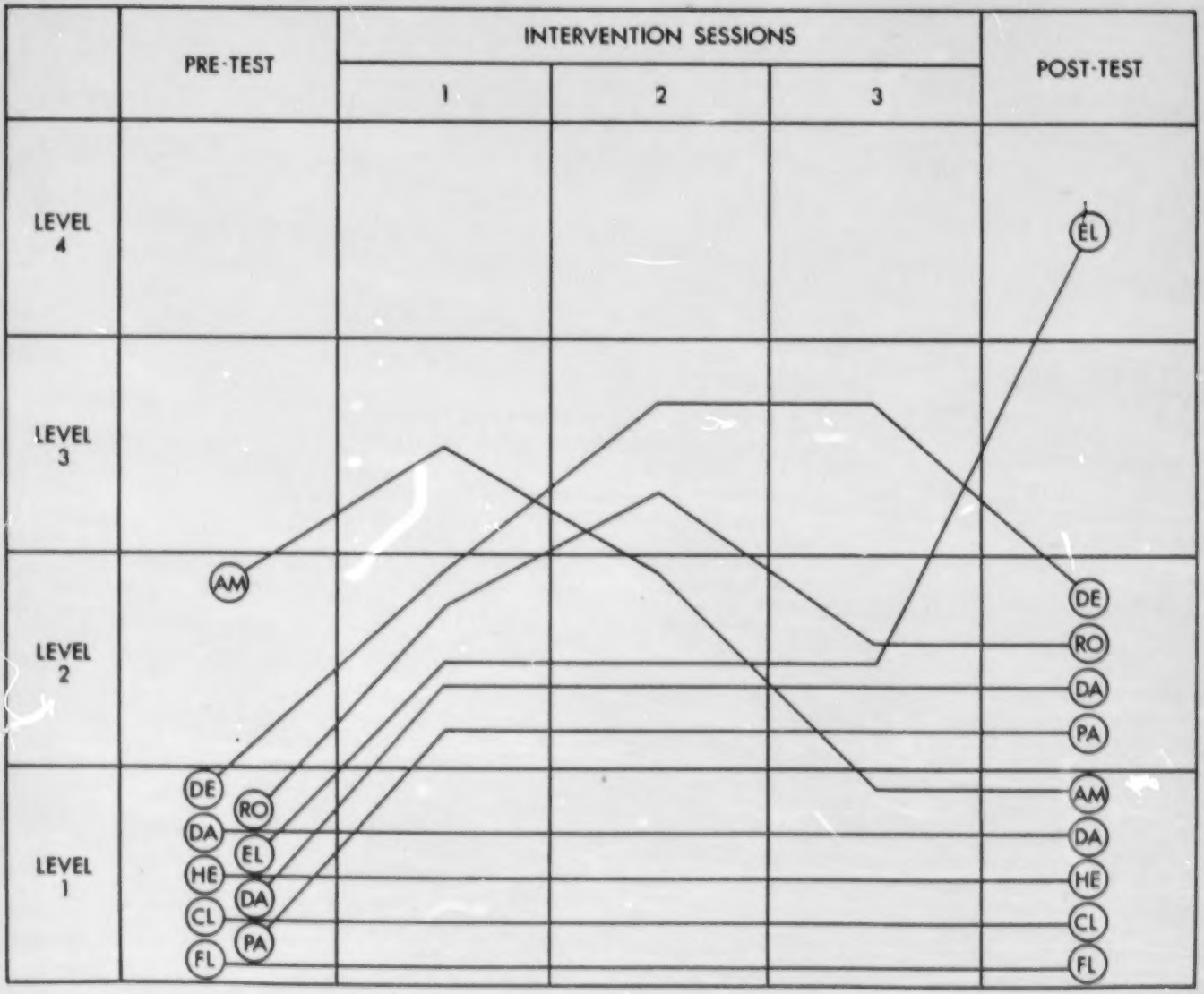
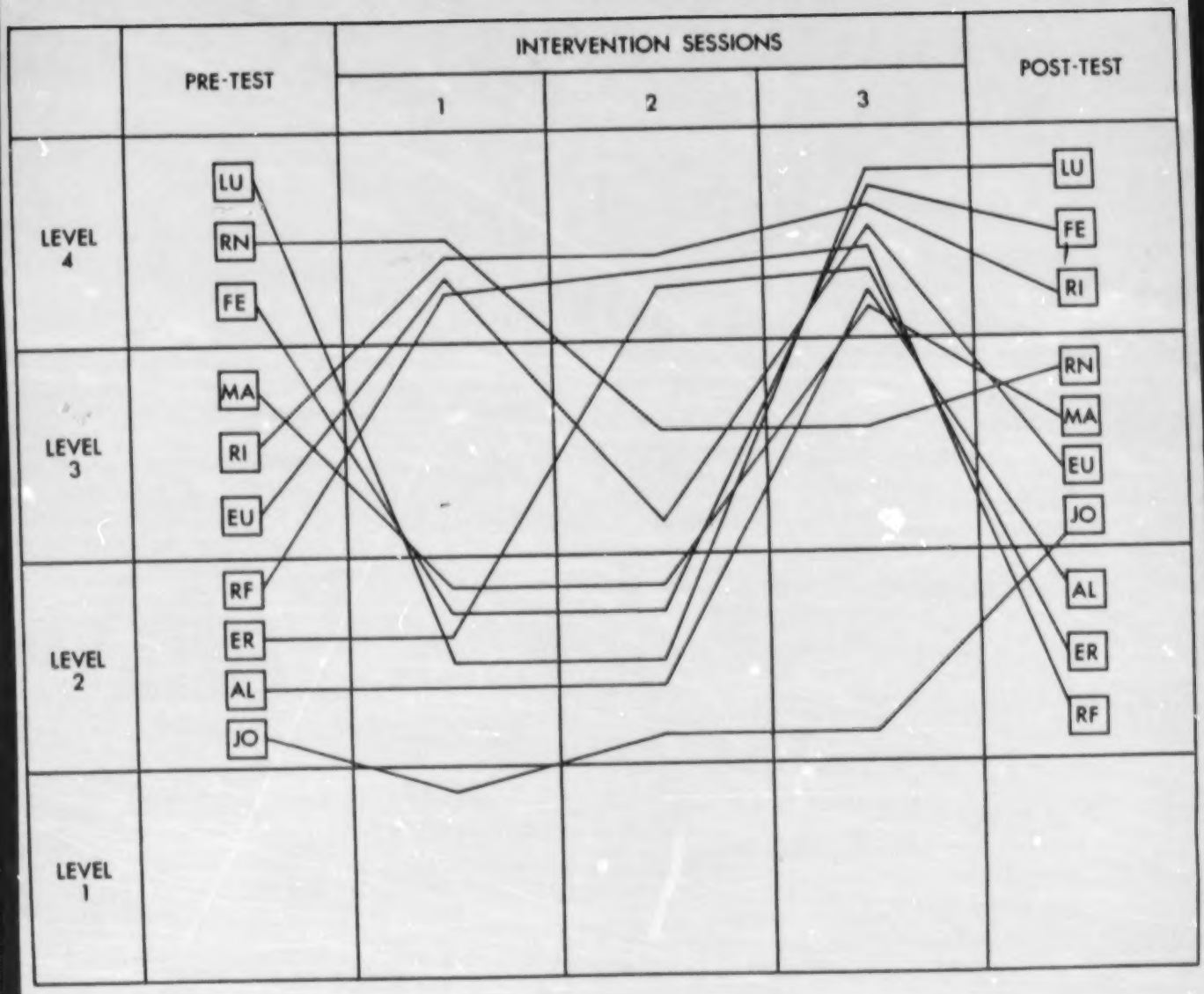

PRE-TEST
INTERVENTION SESSIONS
1
2
3
POST-TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
AM
DE
RO
DA
EL
HE
DA
CL
PA
FL
EL
DE
RO
DA
PA
AM
DA
HE
CL
FL

Figure 4

PROFILES BY LEVELS OF PERFORMANCE IN THE TEST "THE HANOI TOWER"

SPECIFIC POSITION OF EACH SUBJECT AT EACH TESTING SESSION

HIGHER LEVEL SUBJECTS - INDIVIDUAL CONDITION


PRE-TEST
INTERVENTION SESSIONS
1
2
3
POST-TEST
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
LU
RN
FE
MA
RI
EU
RF
ER
AL
JO
LU
FE
RI
RN
MA
EU
JO
AL
ER
RF